(6) M - Define the torque of a couple
(7) S - Apply the principle of moments to objects experiencing torque
(8) C - Practice challenging questions of moments and torque

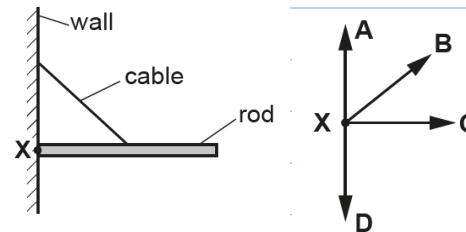## Couples and Torques

▶ 0:00:00

STARTER:

A uniform horizontal rod is hinged at point X and at rest. A support cable is attached at the midpoint of the rod.

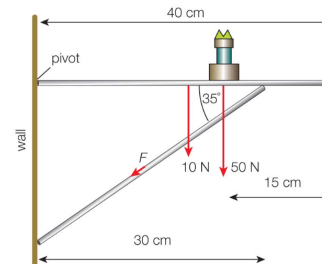**Which arrow** best represents the direction of the force on the rod at point X.

Ex: Write your justification

wall

cable

rod

X

A B C D

This shelf is held up by 2 support brackets,

What is the compressive force, 'F' in each of the brakets?

○ 29.5 N

○ 84 N

○ 42 N

○ 24 N

40 cm
pivot
35°
F
10 N   50 N
15 cm
wall
30 cm

a State the two conditions necessary for a system to be in equilibrium. [2]

b The diagram shows a painter's plank resting on two supports A and B. The plank is uniform, has a weight 80 N and length 2.00 m. A painter of weight 650 N stands 0.55 m from one end.

0.15 m   0.55 m   0.15 m
A   B
1.00 m   1.00 m
80 N   650 N
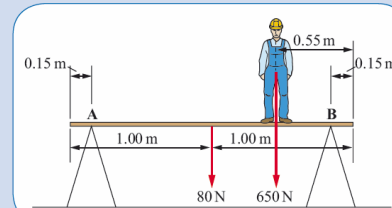
   i Show that the force acting on the plank at the support B is approximately 540 N by taking moments of all the forces about the support at A. [3]   Hint
  ii Calculate the force acting on the plank at support A. [2]   Hint
 iii Describe and explain what happens to the forces on the plank at A and B if the painter moves towards the support at A. Quantitative values are not required. [3]

a Net force = 0 [1]
   Net torque = 0 [1]
b i Sum of clockwise moments = sum of anticlockwise moments [1]
   $(80 \times 0.85) + (650 \times 1.30) = F \times 1.7$ [1]
   $F = 537 \, N \approx 540 \, N$ [1]
  ii Force at A + force at B = 650 + 80 [1]
   Force at A = 730 − 540 = 190 N [1]
 iii The force at A increases. [1]
   The force at A decreases. [1]
   The sum of the forces at A and B is always equal to 730 N. [1]

(6) M - Define the torque of a couple
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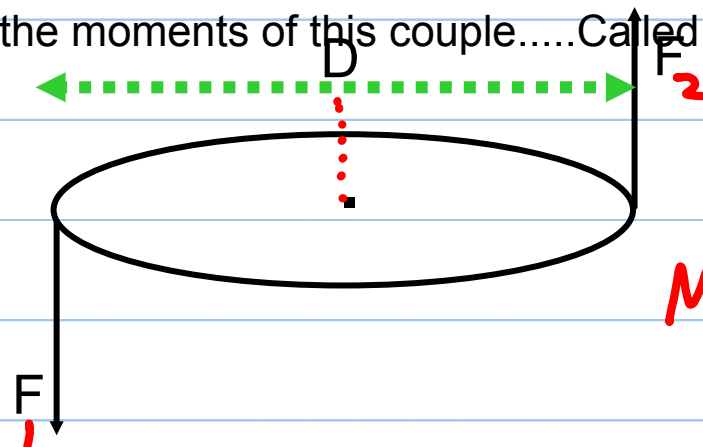
Activity: What is a couple? What is a torque? discuss and jot down an idea. Now look up and record.

Ex: Can you think of 5 engineering situations where these ideas can be a

0:00:00
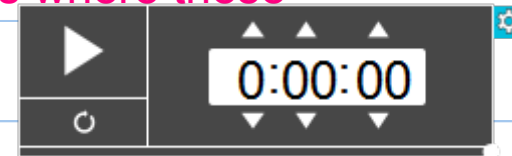
A **couple,** is a pair of equal and parallel but opposite forces, which tend to produce rotation only.

Consider the moments of this couple.....Called **torque**

D F_2

$$M_T = M_1 + M_2$$
$$= f_1 \times 0.5D$$
$$+ f_2 \times 0.5D$$

F_1

What is the **torque** of this couple?
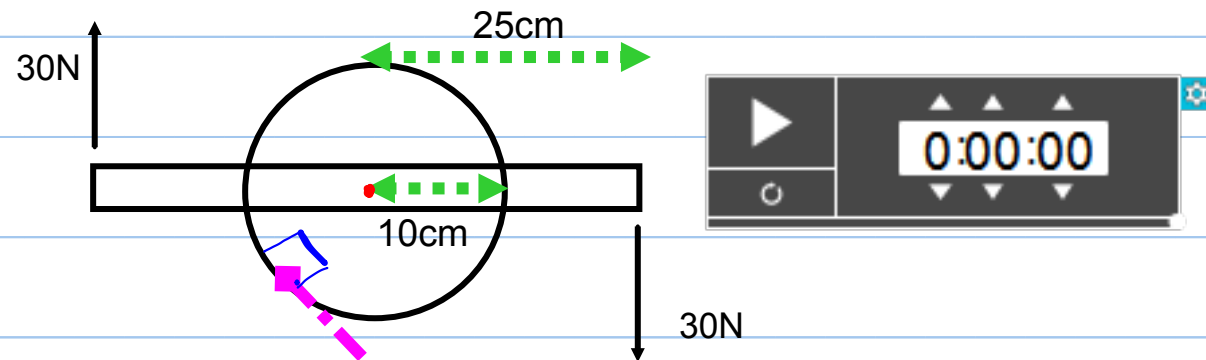
Torque = moment = $F \times D$ $0.5FD + 0.5FD$

torque of a couple
  $=$ one of the forces $\times$ perpendicular distance
                between the forces

(6) M - Define the torque of a couple
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Activity:

25cm

30N

10cm

30N

0:00:00

1. Calculate the torque provided from the black arrow forces?
2. What tension in needed in the pink rope to prevent the disk from rotating? Check answers on P60-61
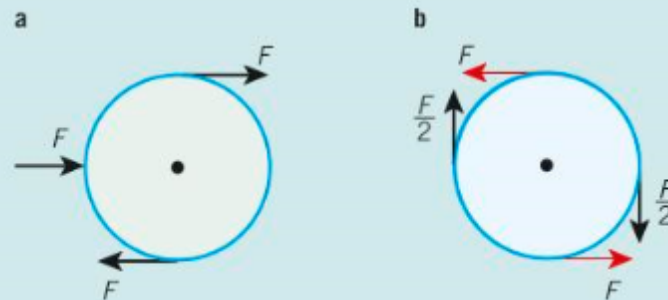3. Give areal life examples of when the above is useful?

Complete summary questions on page 61

(6) M - Define the torque of a couple
(7) S - Apply the principle of moments to objects experiencing torque
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Summary questions

`0:00:00`

1 A snooker ball is resting on a table. A single off-centre force is applied to its surface with a cue. Describe the subsequent motion of the ball. (2 marks)
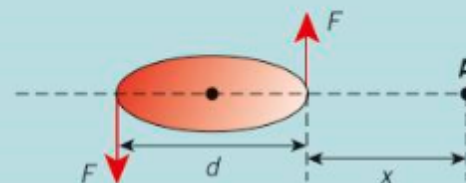
2 The top of a kitchen tap has diameter 4.0 cm. Estimate the torque required to open such a tap using your thumb and one of the other fingers. (3 marks)

a   b

▲ Figure 5

3 Figure 5 shows two discs placed on a smooth horizontal surface.

Describe qualitatively the type of motion each disc will perform. (4 marks)
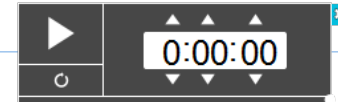
4 Figure 6 shows a couple acting on an object.

▲ Figure 6

a Determine the total moment of the couple about the point A. (2 marks)
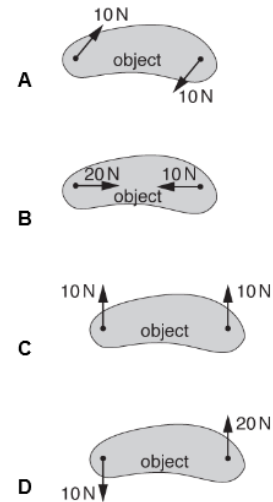
b What can you deduce from this calculation? (1 mark)

(6) M - Define the torque of a couple
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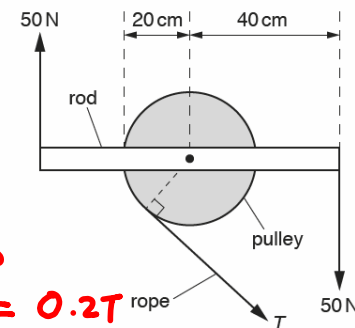
Plenary

0:00:00

Two forces act on an object in the same plane.

Which diagram shows a couple?

A

10N
object
10N

B

20N 10N
object

C

10N   10N
object

D

20N
object
10N

5   A rod is fixed to a pulley. Two 50N forces are applied to the ends of the rod as shown. The tension in the rope attached to the pulley is T. The system is in equilibrium.

50N   20cm   40cm

rod

pulley

$M = 50 \times 0.8$
$= 40 \, Nm = 0.2T$

rope

50N

T

Not to scale

What is the moment of the tension T about the centre of the pulley?

A   10Nm

B   20Nm

C   30Nm

D   40Nm

Your answer   [1]

A